Claims:

1. A method of preparing metal chalcogenides from elemental metal and metal compounds, the method comprising

   a. providing at least one chalcogen;
   b. providing at least one element from periodic table groups 13-15;
   c. providing at least one elemental metal or metal compound;
   d. combining and heating the chalcogen, the group 13-15 element and the metal at sufficient time and temperature to form a metal chalcogenide.

2. The method of claim 1 wherein the chalcogen and group 13-15 element are combined before combination with the metal.

3. The method of claim 1 wherein the element from groups 13-15 is B, Al, Ga, In, Si, Ge, Sn, Pb, P, As, Sb, Bi or a combination thereof.

4. The method of claim 1, wherein the metal compound is selected from TiO_2, V_2O_5, MnO_2, Fe_2O_3, Fe_3O_4, NiO, NbO, Nb_2O_5, MoO_2, MoO_3, RuO_2, Wo_3, Y_2O_3, Ce_2O_3, Nd_2O_3, Sm_2O_3, Eu_2O_3, Tb_4O_7, or Er_2O_3.

5. A method of preparing metal sulfides and polysulfides from metal oxides, the method comprising

   a. providing boron, pure sulfur, and pure metal oxide powder;
   b. placing the boron and sulfur in a first tube;
   c. placing the metal oxide powder in a second tube;
   d. placing the two tubes into a larger container;
   e. evacuating and sealing the container;
   f. gradually heating the container to about 400-900 °C; and
   g. keeping the container at that temperature until little or no boron remains.

6. The method of claim 5, wherein step a. utilizes as a metal oxide the compound Nd_2O_3, from which is synthesized NdS_2, and step f. heats the container to about 450 °C.

7. The method of claim 5, wherein step b. comprises placing a stoichiometric excess of sulfur into the first silica tube.

8. The method of claim 5 step a., wherein sulfur can be replaced by selenium or tellurium.

9. A kit comprising:

a. boron;

d. a chalcogen; and optionally

e. an elemental metal or a metal oxide, two small tubes and a larger container capable of holding the tubes, the container further being capable of being sealed;.

10. A method of preparing ultralong TaS_3 nanowires from tantalum metal, the method comprising

a. providing at least one piece of tantalum;

b. providing and placing boron and sulfur in a first tube;

c. placing the tantalum piece in a second tube;

d. placing the two tubes into a container;

e. evacuating and sealing the container;

f. gradually heating the container to about 300-600 °C; and

g. cooling the container to room temperature.

11. The method of claim 10 wherein the sulfur of step b. is replaced with selenium to produce tantalum triselenide.

12. A battery comprising TaS_3 as a positive anode.

13. A method of preparing indium sulfide (In_2S_3) from In_2O_3, the method comprising

a. providing boron, pure sulfur, and pure In_2O_3;

b. placing the boron and the sulfur in a first tube;

c. placing the In_2O_3 in a second tube;

d. placing the two tubes into a container;

e. sealing the container;

f. gradually heating the container to about 400-900 °C;

g. keeping the container at that temperature for about two days or until little boron remains; and

h. allowing the container to cool.

14. A method of preparing lead sulfide (PbS) from PbO, the method comprising

a. providing boron, pure sulfur, and pure PbO;

b. mixing and placing the boron and the sulfur in a first tube;

c. placing the PbO in a second tube;

d. placing the two tubes into a larger container;

e. evacuating and sealing the container;

f. gradually heating the container to about 400-900 °C;

g. keeping the container at that temperature for about two days or until little boron remains,

whereby the PbO turns into PbS.

15. The method of claim 14, wherein the pure sulfur of step a. is replaced with pure tellurium to produce PbTe.

16. A method of preparing $KInS_2$ from K_2CO_3 and In_2O_3, the method comprising

a. providing boron, pure sulfur, pure K_2CO_3 and pure In_2O_3;

b. placing the boron and the sulfur in a first tube;

c. placing the K_2CO_3 and In_2O_3 in a second tube;

d. placing the two tubes into a larger container;

e. evacuating and sealing the container;

f. gradually heating the container to about 500-700 °C; and

g. keeping the container at that temperature for about two days or until little boron can be seen in the first tube.

17. A method of preparing $NaInS_2$ from NaF and In_2O_3, the method comprising

a. providing boron, pure sulfur, pure NaF and pure In_2O_3;

b. placing the boron and the sulfur in a first tube;

c. placing the NaF and In_2O_3 in a second tube;

d. placing the two tubes into a larger container;

e. evacuating and sealing the container;

f. gradually heating the container to about 400-600 °C; and

g. keeping the container at that temperature for about three days or until little boron remains.

18. The method of claim 17, wherein the sulfur of step a. is replaced with selenium to produce $NaInSe_2$.

19. A method of preparing $NaBiS_2$ from $NaBiO_3$, the method comprising

a. providing boron, pure sulfur and pure $NaBiO_3$;

b. placing the boron and the sulfur in a first tube;

c. placing the $NaBiO_3$ in a second tube;

d. placing the two tubes into a larger container;

e. evacuating and sealing the container;

f. gradually heating the container to about 400-600 °C; and

g. keeping the container at that temperature for about three days or until little boron remains.

20. A method of preparing semiconducting chalcogenide nanoparticles and controlling sizes and morphologies in solution, the method comprising

a. providing at least one metal compound;

b. providing at least one chalcogen

c. providing at least one element selected from the periodic table groups 13–15 (B, Al, Ga, In, Si, Ge, Sn, Pb, P, As, Sb and Bi); and

c. mixing the metal compound, the chalcogen and the element in a solution at sufficient temperature and time to produce precipitate.

21. A method of preparing CdSe nanocrystals and controlling their size, the method comprising

a. providing pure B_2Se_3 dissolved in an amine;

b. providing pure $CdCl_2$ dissolved in an amine;

c. mixing the two solutions; and

d. heating the resulting solution to a temperature in the range of about 50 to 250 °C for selected reaction periods,

whereby the CdSe nanocrystals form and their size varies with the temperature and reaction period.

22. The method of claim 21 wherein the heating in step d. is performed in a conventional oven or a microwave oven.

23. The method of claim 21, wherein the mixture is heated to 60 °C for 30 minutes in a conventional oven, to produce an average diameter of 2.3 nm.

24. The method of claim 21, wherein the mixture is heated to 60 °C for two hours in a conventional oven, to produce an average diameter of 3.4 nm.

25. The method of claim 21, wherein the mixture is heated to 135 °C for 5 seconds in a microwave, to produce an average diameter of 5.0 nm.

26. The method of claim 21, wherein the mixture is heated to 150 °C for 30 seconds in a microwave, to produce an average diameter of 5.4 nm.

27. The method of claim 21, wherein the mixture is heated to 200 °C for overnight in a conventional oven, to produce an average diameter of 11 nm.

28. The method of claim 21, wherein the mixture is heated to 150 °C for 30 seconds in a microwave, to produce an average diameter of 12.8 nm.

29. A method of preparing CdS nanocrystals of controlled size, the method comprising

a. providing pure B_2S_3 dissolved in an amine;

b. providing pure $CdCl_2$ dissolved in an amine;

c. mixing the two solutions; and

d. heating the resulting solution to a temperature of about 100 °C for 40 seconds by microwave irradiation.

30. A method of preparing ZnSe nanocrystals of controlled size, the method comprising

a. providing pure B_2Se_3 dissolved in an amine;

b. providing pure $ZnCl_2$ dissolved in an amine;

c. mixing the two solutions; and

d. heating the resulting solution to a temperature 100 °C for 40 seconds by microwave irradiation.

31. A method of preparing PbSe nanocrystals of controlled size, the method comprising

a. providing pure B_2Se_3 dissolved in an amine;

b. providing pure $PbCl_2$ dissolved in an amine;

c. mixing the two solutions; and

d. heating the resulting solution to a temperature 100 °C for 40 seconds by microwave irradiation.

32. A method of functionalizing the surface of semiconducting nanoparticles, the method comprising

a. providing at least one metal compound;

b. providing one chalcogenide having a cation selected from groups 13 - 15 (B, Al, Ga, In, Si, Ge, Sn, Pb, P, As, Sb and Bi);

c. dissolving the chalcogenide in a first solution;

d. dissolving the metal compound in a second solution;

e. providing and dissolving a functional capping agent in at least one of the first or second solution; and

f. combining all the solutions; and

g. maintaining the combined solution at a proper temperature for an appropriate time.

33. The method of claim 32, wherein the first and second solutions are the same.

34. A method of preparing CdSe nanocrystals of controlled size, the method comprising

a. providing pure B_2Se_3 dissolved in a polar solvent and 1,3-dimethyl-2-imidazolidinone at about a 1:50 mole ratio;

b. providing pure $CdCl_2$ dissolved in the polar solvent and 1,3-dimethyl-2-imidazolidinone at about a 1: 50 mole ratio;

c. mixing the two solutions; and

d. heating the resulting solution to a temperature of about 70 °C for about 30 minutes in a conventional oven.